7-2009

Improving Achievement and Attitude Through Cooperative Learning in Math Class

Scott Johnsen
Curtis, NE

Improving Achievement and Attitude Through Cooperative Learning in Math Class

Scott Johnsen
Curtis, NE

Math in the Middle Institute Partnership
Action Research Project Report

in partial fulfillment of the MAT Degree
Department of Mathematics
University of Nebraska-Lincoln
July 2009

Improving Achievement and Attitude Through Cooperative Learning in Math Class

Abstract

In this action research study of my classroom of eighth grade mathematics, I investigated the use of cooperative learning groups and whether working in groups changed students' individual achievement and students' attitudes toward mathematics. I used my eighth grade class of 13 students along with two different types of group formations: teacher-formed groups and student-formed groups. I discovered that the type of group formation can have an impact on the attitudes of students and how well they work together. I also discovered that there was no real change in students' achievement, but the longer the group worked together the better they performed. As a result of this research, I plan to continue to find ways to incorporate cooperative group activities but keep groups together for a longer period of time.

In the public school setting, many classrooms have students with a wide range of abilities, but all are working toward the same goal. Students learn and understand mathematical concepts in a variety of different ways. Teachers have the sometimes-difficult task of trying to identify which strategy works best for each individual student. I believe that in many instances, students can learn better from other students. Working cooperatively is an important life skill that students can use outside the classroom to help work effectively with others to solve any problem or task.

Throughout my years of teaching, I became frustrated with the long line of students who were asking questions on homework problems. After my first summer of the Math in the Middle program, I began to realize how much it helped me to be able to discuss with other teachers the mathematical problems that my peers and I were trying to solve. I wanted to help my own students realize that working together toward a common goal with other students can be beneficial to all of them. Although the correct answer is important, I want my students to also realize the importance of understanding the strategies and methods used to solve a problem. My hope is that a student will not just agree that another student's answer is correct but ask, "How did you work the problem?" or "How did you get that answer?" Exploring together can help them to realize that there are sometimes many different methods that can be used to solve a problem.

Problem Statement

This issue of group learning follows closely with the National Council of Teachers of Mathematics' (NCTM) process standard of communication. Students can communicate ideas with their peers about ways to solve particular problems. A student who understands a concept can share his or her ideas and strategies with other students. Sometimes it may be a situation

where students are brainstorming ideas with one another until a decision is reached as to which may be the best method or approach. This work also would follow the NCTM's principle of equity. There would be high expectations for students to be able to work cooperatively and support one another as they work together.

I would love to create an ideal classroom where all of my students felt comfortable sharing their ideas and strategies with one another. The interaction within cooperative groups helps students feel confident in their own abilities. I feel that it is very beneficial for students to realize that the same problem can be solved by different strategies and still arrive at the same result or conclusion. The cooperative communication between students also can be very beneficial in other curriculum areas where the discussion of ideas is prevalent. Teachers are trying to prepare students for what happens after schooling is done. A person who can work with others cooperatively and willingly share his or her ideas can be a productive member of today's society.

Literature Review

In the early days of formal education, with the one-room schoolhouse, teachers relied on students helping other students with their learning. As the population increased and schools became larger, the schools also became more specific to age- and grade-appropriate separation. This changed the way teachers worked in the classroom more toward direct instruction where students worked individually. During the past several years, many studies have been done focusing on topics similar to the early days of teaching and using cooperative learning. The research provides readers with the following themes related to cooperative learning: grouping students, students' academic achievement, group reward system, and students' attitudes.

According to Oxford American Dictionary, cooperative learning can be defined as a small group of students who are working together on a common learning task. Each student plays an important role of helping one another achieve this common goal. Cooperative learning begins with the formation of groups into teams of students. Whicker, Bol, and Nunnery (1997) studied 31 high school juniors and seniors divided into two classes where one class studied material cooperatively and the other class studied independently. They used surveys of students and found that most students indicated that they liked working in groups and getting help from other students. Cooperative groups consisted of five members and included one student from the top fourth of the class, one student from the bottom fourth of the class, and three students from the middle half of the class (Whicker et al., 1997).

Bernero (2000) studied 25 second grade Black and Hispanic students working in cooperative groups. Bernero used surveys of teachers and students and found that students felt more comfortable working in a cooperative group. Students were placed in pairs or groups of three and used many manipulatives to work on problems. Gillies (2004) studied the effects of cooperative learning on 223 ninth grade students in structured and unstructured groups. Gillies found that students in structured groups were more willing to work with others on assigned tasks and provide assistance to their peers than the students in the unstructured groups. The students worked in three- or four-person mixed-gender and mixed-achievement groups.

Anderson (2005) studied 420 junior and senior college students in a comparison of cooperative learning and traditional lecture-based biochemistry curriculum. Anderson found that students in the cooperative learning environment scored higher than their peers in standardized testing of the curriculum and were more positive about their learning experience. The cooperative learning classes were split into tutorial groups of five to six students, each meeting in

a small room for one hour per session. These classes met for the same total number of hours per semester as did the traditional lecture-based classes. Each tutorial group included a senior biochemistry major or first-year graduate student as an educational assistant (Anderson, 2005).

Finding similar results in a different college setting, Yamarik (2007) studied a total of 116 students enrolled in intermediate macroeconomics classes in the spring of 2002 and the fall of 2004. Using multivariate regression analysis, he found that students taught by cooperative learning achieved greater academic performance in the form of higher exam scores. Cooperative groups were established with three or four students that were heterogeneous in aptitude based on a 10-question test to measure mathematic skills.

In the above studies, the size of the group varied depending on the level of the students, the older the students, and the larger the size of the groups. Each of the studies showed an average of four students per group and mixed the groups according to the abilities of the students. The distribution of the ability levels in the groups included a high-ability learner, a low-ability learner, and two medium-ability learners. The methodology of the research of each of the cases looked at a comparison between two groups of students. One group of students was being taught by using cooperative learning whereas the other group was using a more traditional lecture classroom setting.

Many studies have shown that students' academic achievement was better for students who were involved in a cooperative learning environment, and the effects of cooperative learning on student achievement can be impressive. For example, the cooperative learning students in Whicker et al. (1997) had increasingly higher test scores than the students in the comparison group and significantly outscored the comparison group on the third chapter test. Students working together toward a common goal enjoy the feeling of helping one another to be

successful, and the longer the groups worked together, the more beneficial this group work seems to become.

The use of groups divided according to their abilities was beneficial to all students. Students can learn best from one another when they are required to provide reasoning for their answers or explain how they arrived at the answers (Walmsley, 2003). For mainstreamed and slower students, cooperative learning seemed to help bring them up to speed, possibly because it allowed discussion among group members and a willingness on the team members' parts to help and explain both concepts and processes (Bernero, 2000).

Yamarik (2007) found three possible reasons why cooperative learning groups performed better on exams. First, cooperative learning raised student-instructor interaction. Students felt more comfortable asking questions as a group than individually. Second, cooperative learning increased group studying for the exams. Third, the novelty of working in small groups sparked greater interest in the material.

Each of the research projects previously mentioned found that there was an increase in student achievement when using cooperative learning. When students strategize together and discover various ways to solve a problem, they developed a better understanding of the concept. There was a big contrast in the age of the students that were studied. One study researched second grade students, whereas the other three studies researched high school- and college-aged students. The methodology used compared students in two different groups using different learning styles for two of the previously mentioned articles. The methodology of the other researched articles compared a group of students and their achievement based on how they have performed previously.

Making sure that students work cooperatively in their groups can sometimes be a difficult task. Some students may rely too heavily upon their members to obtain answers to problems without understanding how those answers were obtained. A possible solution to this dilemma is to use a group reward system. Both group rewards and individual accountability are necessary for cooperative methods to be most effective (Whicker et al., 1997). A reward can be used when each student of the group performs at or above expectations.

Walmsley (2003) used a group reward system based on student test scores. An average baseline score, based on previous tests, was calculated for each student. If each member of the group scored at or above his or her baseline score, then the entire group received bonus points. This type of reward system encouraged students in each group to make sure that everyone in the group understood the material before a test. It reinforced the value of individual accountability and at the same time created the possibility of earning extra-credit points if everyone in the group did well on the test (Walmsley, 2003).

Whicker et al. (1997) used a similar type of reward system with a little difference. Using the same type of baseline score calculation, a student could earn four extra points if his or her test score was 1-10 points above the base score. Six extra points could be earned with a test score that was more than 10 points above the base score or if the student achieved a perfect paper. Team scores were computed by adding all the points earned by group members and dividing the sum by the number of members in the group that took the test (Whicker et al., 1997). The team with the best score would then receive some type of recognition or reward.

Both Whicker et al. and Walmsley researched high school students in a mathematics classroom. Each study used a reward system to help promote the use of cooperative learning so that all students would have the opportunity to be successful. Both studies found that it took time

for groups to bond with one another and work together effectively. A major contrast between the two was how the studies were performed. Whicker et al. (1997) used a quasi-experimental design and compared two different class groups using different teaching strategies, and Walmsley (2003) used a single classroom setting and looked at how these students performed based on previous knowledge about the class's performance.

Attitude is defined as a way of thinking or feeling about something. When working with students, their attitude can play an important role in the learning process. If a student feels that he or she can do well and be successful, then he or she usually is successful. However, if a student feels that he or she cannot do the required work, then he or she may not be willing to put forth the effort needed to be successful. Cooperative learning can be a useful tool to help develop a positive attitude toward learning. In the study by Bernero (2000), those students who struggled with math continued to struggle and became frustrated with individual work, but improved both academically and in self-confidence (thus leading to social improvement), when it came to group work. Students working cooperatively often enjoy the experience and believe that their classmates like them. This belief that they are accepted by others also allows the students to believe that they are more successful academically. This perception of success increases students' self-esteem (Walmsley, 2003).

Cooperative learning has been linked to other positive social or affective outcomes. One benefit is the increase in social skills of students who participate in group work (Whicker et al., 1997). These skills can help students perform in situations outside of the school setting. Being able to work with others can be a very useful attribute to have when seeking employment in many companies.

It is important to create an atmosphere in the classroom where students feel comfortable to share their ideas. This may take time for the group members to become aware of the strengths that each member can bring to the entire group. Structure of the groups is important. In the research by Gillies (2004) and Yamarik (2007), children in the structured groups demonstrated less non-cooperative behaviors and less off-task behaviors than their peers in the unstructured groups. They were more willing to work with others on the task, listen to what they had to say, and share ideas and information (Gillies, 2004). The novelty of working in small groups sparked a greater interest in the material (Yamarik, 2007).

Understanding what happens as students work cooperatively together – in particular, how they interact to facilitate learning and how they perceive these experiences – is critical to understanding how this approach to learning can be used more effectively in classrooms to achieve academic and social goals (Gillies, 2004). Helping students to achieve at the highest academic level possible is important to me. Cooperative learning has been shown with the reviewed literature to be a useful method at achieving this goal. My study took a look at the academic achievement and attitude of middle school math students. While Whicker et al. (1997) also studied achievement and attitude, their study focused on eleventh and twelfth grade students and my focus was on eighth grade students.

When students are required to explain, elaborate, and defend their positions to others, they may be forced to think more deeply about their ideas. However, students who are listening to the explanations of others are exposed to – and must think about – other approaches to a given task (Walmsley, 2003). Student relationships and social skills can improve when cooperative learning is used correctly. It was my intention with this study to help my students become more appreciative of others and learn how to effectively work with others. While many studies have

been done comparing two groups of students using different learning strategies, my study looked at one single class using the cooperative learning strategy and how they improved as a class.

Purpose Statement

The purpose of my project is to use group learning to help improve students' scores on assessments by developing a positive attitude toward mathematics. I will be examining the research themes of student achievement and student attitude, in seeking to answer the research questions:

- How will students' attitudes toward math change after cooperatively learning and working in small groups?
- What happens to students' individual achievement after working in cooperative learning groups?
- What happens to my teaching and classroom when I implement cooperative learning groups and teach students how to work in groups cooperatively in math class?

Through this investigation, I hope to better understand if using a cooperative learning approach helps students understand and enjoy mathematics more. The students will be given the opportunity to use each other as a resource to solve problems. The success of the group depends on the cooperation among all group members.

Method

On the first day of research (February 12, 2009), students were asked to complete a pre-project survey (see Appendix A). On the second day, the students were placed in groups assigned by the teacher based on their previous curriculum assessment scores. Each group consisted of one student from the top 33%, one student from the middle 33%, and one student from the bottom 33%. Since the class consisted of 13 total students, one student from the middle 33% was randomly assigned to create a group of four students. The students remained in these groups for the first four weeks of the project. Each day of class, a short introduction was given to the

students about the topic of the day, and then students worked together to solve the problems that were assigned. One day each week the students were given a review sheet, with the answers given, to make sure that each member of the group understood how to work each problem. This review sheet consisted of problems similar to the homework problems from the previous two weeks.

Two different types of individual assessments were given during this project: four curriculum assessments and five state standard assessments. Curriculum Assessments 1, 3, and 4 consisted of 20 open-ended items involving various types of computation and problem solving. There were 100 points possible for each assessment, and partial credit was awarded for any correct but incomplete answers. Curriculum Assessment 2 consisted of 10 open-ended items and was 50 points possible with partial credit awarded for any correct but incomplete answers.

A group reward system was set up based on the curriculum assessment scores. Each student was given a baseline score based on their previous curriculum assessment average score (before the project began) minus four points. I chose to subtract four points because I knew that the curriculum was getting more difficult. The reward was 10 bonus points for all members of a group if each member of the group scored at or above his or her baseline score. During the teacher-formed group period, data was collected on scores on Curriculum Assessments 1 and 2 (March 4 and March 17) and three different state standard assessments (March 5 and March 20).

On March 23, students then were divided into groups of their own creation. During this student-formed group period, data was collected on scores of Curriculum Assessments 3 and 4 (April 1 and April 16) and two different state standard assessments (April 2 and April 3). The same group reward system was used as was used for the teacher-formed groups. The class average on each curriculum assessment was compared to the class average before the project

began. For each state standard assessment, I compared the total number of students who met or did not meet the standard to the average number of students for each category for all previous state standards assessments taken before the project began.

During the last week of the project (April 13), six students were randomly selected to answer a specific set of interview questions (see Appendix B). Following the completion of the project students were asked to complete a post-project survey (see Appendix C). The surveys and interview responses were used to help determine how students' attitudes changed during the cooperative group learning process.

A personal teacher journal also was used as another form of data collection. At the end of the day on Thursday of each week, I would journal about specific group related activities for the week. During the 10-week project period, I also commented on what I noticed about the students' attitudes related to group work.

Findings

The research for this paper took place in a K-12 school system of approximately 220 total students located in a small southwest Nebraska community. The "average day" of teaching during this action research project began by discussing and going through any student questions that arose from the previous day's problems. Then a short introduction was given to the students about the new concept. The majority of the class time was used for cooperative group work. Students worked together on a specific set of problems from the textbook. In some circumstances, the students were given general instructions about a topic and allowed to discuss and formulate their own conclusions. These conclusions then were shared with the rest of the class until everyone agreed upon a final accepted conclusion. Generally, this type of activity worked well when all students experienced some type of success at the beginning of the activity.

March and April in a small school became a difficult time to incorporate this type of research activity. Many students are involved in several different activities, which caused them to miss class. This would cause some problems with the group formations if more than one member of a particular group would happen to be absent the same day. It has been difficult at times when students are gone to a Future Farmers of America organization event or a Family Career and Community Leaders of America event or some other activity. At times up to half the class was gone making it very difficult to do group projects. During interviews with the students, some of them commented that it was helpful when their group members would help them when they were absent. This made it easier for me because the students were able to help one another. It was as if there were 13 teaching assistants in the classroom.

During this action research project, I was trying to answer questions related to: 1) How will students' attitudes toward math change after cooperatively learning and working in small groups? 2) What happens to students' individual achievement after working in cooperative learning groups? 3) What happens to my teaching and classroom when I implement cooperative learning groups and teach students how to work in groups cooperatively in math class?

How will students' attitudes toward math change after cooperatively learning and working in small groups? Attitude can play a very important role for the success of many students. If a student believes that he or she can be successful then many times he or she will be successful. At the conclusion of this project, my assertion is that there is a slight increase in attitude toward math after group work.

The students enjoyed working with one another on solving problems. The type of group formation was mixed among the students. Some students liked it better when the groups were formed by the teacher and others liked it better when the students formed their own groups. All

the students agreed that it is important to have group members who are willing to help. The two most common responses to the question on the post-project survey that said "when working in groups, I wish I could work with a person who is" were a person who is "smart" and "understanding."

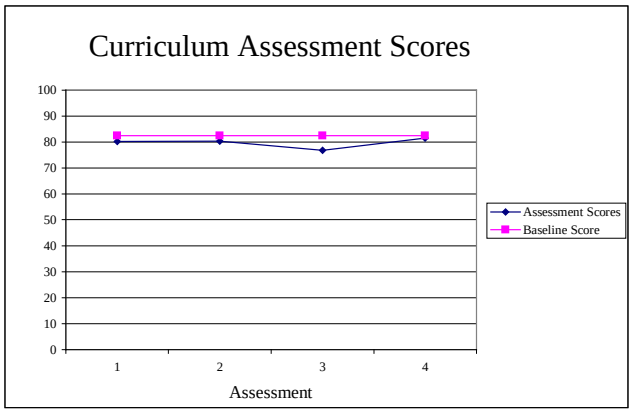
The pre-project survey and post-project survey showed a slight increase in results as to changes in attitudes. When asked to rate the question, "I have more confidence to try problems when I work in a group," the responses were exactly the same on both the pre- and post-project surveys. When asked the question, "When I think of Math, I think nervous, both, or calm", six students chose calm on the pre-project survey compared to seven students choosing calm on the post-project survey.

During the interviews, four of the six students interviewed said that they noticed changes in other students during group work. The students all agreed that they understood better and did not get as frustrated. Five of the six students interviewed said that they felt that working in groups has prepared them better to take assessments than working alone. Results from the students' pre-project survey showed that nearly 62% of the students compared to the post-project survey of 77% of the students felt that working in a group helps them to understand the concepts better. In my teacher journal I wrote: "I felt that the attitudes of the students was increased during this activity because every student was able to achieve some success at the beginning of the activity."

What happens to students' individual achievement after working in cooperative learning groups? Even though the students themselves felt a little more confident, when looking at the nine different individual assessment scores from this project (four curriculum and five state standard), there was not much change in the performance of the students as a group. At the

conclusion of this project, my assertion is that students' individual achievement remains nearly the same after working in cooperative learning groups.

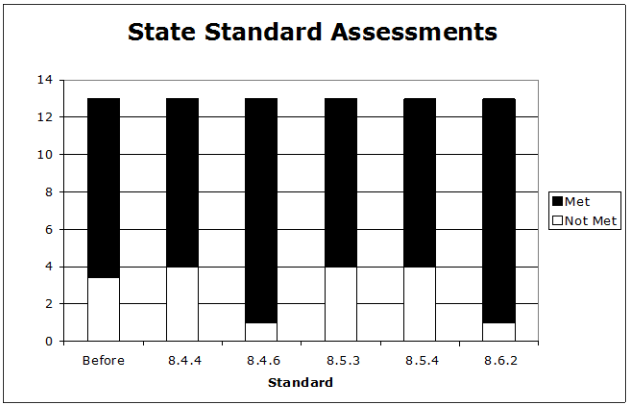
For the curriculum tests, the mean baseline score for the 13 students was an 82.5%. For test 1 (see Appendix D), the mean score was an 80.2%. For test 2 (see Appendix E), the mean score was an 80.4%. For test 3 (see Appendix F), the mean score was 76.8%. For test 4 (see Appendix G), the mean score was 81.5%. This data can be visualized by looking at the following graph.



The first two tests were taken during the time of teacher-formed groups and the second two tests were taken during the time of student-formed groups. I noticed that each time the second test of the different group formations was better than the first test. This causes me to believe that it might be possible that the longer the groups are together, the better they will perform.

For the state standard assessments, I looked at the 16 state assessments that the students had taken prior to my research and found an average of the number of students that were in each of two categories, met and not met. Prior to my study, on average 10 students were in the met category, and 3 students were in the not met category. For State Assessment 1 (NE Standard 8.4.4), 9 students were in the met category, and 4 students were in the not met category. For

State Assessment 2 (NE Standard 8.4.6), 12 students were in the met category, and 1 student was in the not met category. For State Assessment 3 (NE Standard 8.5.3), 9 students were in the met category, and 4 students were in the not met category. For State Assessment 4 (NE Standard 8.5.4), 9 students were in the met category, and 4 students were in the not met category. For State Assessment 5 (NE Standard 8.6.2), 12 students were in the met category, and 1 student was in the not met category. The chart below shows a visual representation of this data.



As an observer, I recorded in my journal a specific time when group cooperation worked well academically. A group of three male students were working on a particular problem. One of the students did not have the same answer as the other two students. Instead of just agreeing with the majority, a discussion took place, and this group noticed that the two students who obtained the same answer were actually incorrect. I thought that this showed the effectiveness that groups can have on their understanding.

Looking at all nine individual assessments taken, the students performed slightly lower than the baseline mean on the curriculum assessments, but performed at or slightly better than the previous average on the state standard assessments. From my observation of classroom work, there were several instances like the above where students helped one another's understanding of

mathematical ideas. Therefore, overall there does not appear to be much change in student achievement during the course of this project.

What happens to my teaching and classroom when I implement cooperative learning groups and teach students how to work in groups cooperatively in math class? As this project progressed, I noticed myself trying to allow the students to work with their group members to answer questions before I intervened. I always have been too quick to intervene when a student is struggling rather than allow them some time to process and think about a possible solution. This project allowed me to be more of an observer and realize that when students work together many productive things can occur when the students are given enough time to discuss with one another.

I noticed that the longer the groups were together, the better the students seemed to be working with one another. At the beginning of the teacher-formed group period, some of the students were not very cooperative with their fellow group members. These students did not feel comfortable working with the other members of the group. As time passed, the students began to realize that each member of their group does have a special skill that could help the group perform better. It seemed to be easier for students to work together when the students formed their own groups. I believe that this is because they were in a group with their friends who they normally associate with during other parts of the day. I did notice, however, that it was easier for the students to become distracted and sometimes not stay on task.

As documented in my personal teacher journal, a specific example of my learning to step back was a group activity involving the discovery of the Pythagorean Theorem. As the students drew three squares to represent the lengths of the sides of the right triangle, I listened to some of the discussions about trying to fit the two smaller squares inside the larger square. I thought this

activity helped many of the students understand the concept much better than me just telling them that this is how it works.

Another example of letting the students discover relationships as a group involved finding how many arrangements of letters could be formed using two, three, and four unique letters. The individual groups began to work together to create lists of the different arrangements. One particular group noticed a pattern in the number of arrangements obtained and were able to explain this to the rest of the class. This and other instances have helped me as a teacher learn that group work can be a beneficial way for students to learn from one another.

Conclusion

The findings of this action research showing an improvement in students' attitudes toward mathematics are very similar to those of Gillies (2004) and Walmsley (2003). These studies also found an increase in students' attitudes after working in cooperative learning groups. Gillies suggests that there is much to be gained by encouraging the use of this non-traditional pedagogical approach to teaching in classrooms, particularly when schools are trying to encourage the development of positive attitudes toward learning, prosocial behaviors among students, and successful learning outcomes for students. My experiences with trying cooperative learning in the classroom convinced me that cooperative learning can have a positive effect on students' achievement and attitudes toward mathematics. My findings of no change in students' academic performance after cooperative learning experiences contrasts with others' findings of increase in academic performance, for example, Yamarik (2007), where the use of cooperative learning was associated with an increase in combined scores of 4.4 and 5.5 points on a 100-point scale.

Cooperatively working together in groups can help to encourage students to be more involved with one another. As I experienced with teacher-formed and student-formed groups and as Gillies (2004) and Yamarik (2007) noted, there are many ways that groups can be nonproductive, so the way that groups are formed can have an impact on student learning. It is important that students are taught how to work cooperatively together. Just placing students together in a group does not always result in cooperative learning.

Implications

After completion of this project, I would like to continue to develop the idea of cooperative learning. My study has convinced me that there are many benefits that can be gained when students work together. The exchange of different ideas and strategies can be beneficial to all students. This exchange of different strategies allows the students to look at math problems through another's perspective. I will share these ideas from my findings in this action project with other teachers who are interested in developing group learning.

I found that it is important to pay attention to which students are placed together in groups. Some students can work with many other students, but there will always be those few who have difficulty contributing to a group atmosphere. It is also very important to teach the students how to work cooperatively together. Next year, I would like to spend a little more time showing students how to work cooperatively in a group and learning how to help students who have trouble working in groups. Students need to feel comfortable working with other members of the group. I am interested in creating team-building activities for the beginning of the year as a possible way of creating a comfortable working atmosphere.

REFERENCES

Anderson, W. L., (2005). Comparison of student performance in cooperative learning and traditional lecture-based biochemistry classes. *Biochemistry and Molecular Biology Education, 33*(6), 387-393.

Bernero, J. (2000). *Motivating students in math using cooperative learning*. (ERIC Document Reproduction Service No. ED446 999).

Gillies, R. M. (2004). The effects of cooperative learning on junior high school students during small group learning. *Learning and Instruction, 14*(2), 197-213.

Walmsley, A. L. (2003). Cooperative learning and its effects in a high school geometry classroom. *Mathematics Teacher, 96*(2), 112-116.

Whicker, K.M., Bol, L., & Nunnery, J. A. (1997). Cooperative learning in the secondary mathematics classroom. *Journal of Education Research, 91*(1), 42-48.

Yamarik, S. (2007). Does cooperative learning improve student learning outcomes? *Journal of Economic Education, 38*(3), 259-277.

APPENDIX A

Student Pre-Project Survey

Circle the appropriate category that best represents your feeling for each type.

When I think of Math, I think . . .

1.	Interesting	Both	Boring
2.	Happy	Both	Sad
3.	Easy	Both	Hard
4.	Useless	Both	Needed
5.	Nervous	Both	Calm
6.	Good Grades	Both	Bad Grades

7. Rank the following in order (1-5) as the best way for you to learn math.
   1 is the best way and 5 is the worst way.

   _____ Working alone on assignments

   _____ Teacher explanations in class

   _____ Reading how to do it in the textbook

   _____ Having a classmate or another person explain it to me outside of class time

   _____ Working in pairs or groups during class time

PLEASE GIVE YOUR HONEST RESPONSE TO EACH STATEMENT.

8. I like to work in groups in math class.	Agree	Neutral	Disagree
9. I ask questions of others when I work in a group.	Agree	Neutral	Disagree
10. Others in the group ask me questions when we work in groups.	Agree	Neutral	Disagree
11. I have more confidence to try problems when I work in a group.	Agree	Neutral	Disagree
12. Working in a group helps me understand the concepts better.	Agree	Neutral	Disagree
13. Working in a group helps me get the work completed on time.	Agree	Neutral	Disagree

14. Working in groups helps me to learn quicker and retain more for the tests. Agree Neutral Disagree

15. When I work in a small group, everyone is encouraged to contribute. Agree Neutral Disagree

16. When I work in a small group, ideas and opinions are treated with respect. Agree Neutral Disagree

17. I am comfortable asking the teacher questions if I don't understand something. Agree Neutral Disagree

18. I am comfortable asking a group member questions if I don't understand something. Agree Neutral Disagree

19. You are asked to work in a group. If you get to choose two people to work with, who would it be and why?

20. I get frustrated in mathematics when . . .

21. The part of mathematics that scares me most is . . .

22. When working in groups, I wish I could work with a person who is . . .

APPENDIX B

Student Interview Questions

What do you like best about math?

Does classroom discussion help your understanding of math?

What can your teacher do during class to help you understand math better?

What part of working in groups is most helpful?

What part of working in groups is least helpful?

Do you feel comfortable correcting your classmates in small groups?

What type of person makes a good group member?

What type of person makes a bad group member?

When you and your group members have different answers, how do you decide who is correct?

What method would you prefer that the teacher use when deciding on group member? (students choose members, random, teacher choose)

Have you noticed any changes in yourself or other students with regard to their math confidence after working in groups?

Do you feel that working in groups has prepared you better for taking assessments than working alone?

Does working in groups help you get involved in your learning? Why or why not?

Is there anything else I should know about you experience in working on this project?

APPENDIX C

Student Post-Project Survey

Circle the appropriate category that best represents your feeling for each type.

When I think of Math, I think . . .

1.	Interesting	Both	Boring
2.	Happy	Both	Sad
3.	Easy	Both	Hard
4.	Useless	Both	Needed
5.	Nervous	Both	Calm
6.	Good Grades	Both	Bad Grades

7. Rank the following in order (1-5) as the best way for you to learn math.
   1 is the best way and 5 is the worst way.

   _____ Working alone on assignments

   _____ Teacher explanations in class

   _____ Reading how to do it in the textbook

   _____ Having a classmate or another person explain it to me outside of class time

   _____ Working in pairs or groups during class time

PLEASE GIVE YOUR HONEST RESPONSE TO EACH STATEMENT.

8. I like to work in groups in math class.	Agree	Neutral	Disagree
9. I ask questions of others when I work in a group.	Agree	Neutral	Disagree
10. Others in the group ask me questions when we work in groups.	Agree	Neutral	Disagree
11. I have more confidence to try problems when I work in a group.	Agree	Neutral	Disagree
12. Working in a group helps me understand the concepts better.	Agree	Neutral	Disagree
13. Working in a group helps me get the work completed on time.	Agree	Neutral	Disagree

14. Working in groups helps me to learn quicker and retain more for the tests. Agree Neutral Disagree

15. When I work in a small group, everyone is encouraged to contribute. Agree Neutral Disagree

16. When I work in a small group, ideas and opinions are treated with respect. Agree Neutral Disagree

17. I am comfortable asking the teacher questions if I don't understand something. Agree Neutral Disagree

18. I am comfortable asking a group member questions if I don't understand something. Agree Neutral Disagree

19. I believe I was taken advantage of by being in small groups because others in my group expected me to do the work. Agree Neutral Disagree

20. I thought that working in groups was too noisy during class. Agree Neutral Disagree

21. You are asked to work in a group. If you get to choose two people to work with, who would it be and why?

22. I get frustrated in mathematics when . . .

23. The part of mathematics that scares me most is . . .

24. When working in groups, I wish I could work with a person who is . . .

APPENDIX D

Curriculum Assessment #1

1. In a large meadow, the ratio of marigolds to petunias was 2 to 5. If there were a total of 49,000 marigolds and petunias in the meadow, how many petunias were there?

2. The product of 7 and the opposite of a number is decreased by 28. If the resulting number is –35, what is the number?

3. On level ground, 24 kilometers can be traversed in 12 minutes. On the incline, the speed is cut in half. How many kilometers can be traversed on the incline in 48 minutes?

4. If 150 is increased by 80 percent, what is the resulting number?

5. Between what two integers is $\sqrt{70}$.

6. If 7x + 3 = 17, what is the value of 11x – 2?

7. Solve: $\dfrac{\frac{3}{4}}{\frac{1}{2}} = \dfrac{\frac{1}{3}}{x}$

8. Solve: -2x + 5 = 3x – 10

9. Simplify: $-2^2 + (-3)^2$

10. Simplify: $3\left[3^2\left(\sqrt{36} + \sqrt[3]{64}\right) - 5\right]$

11. Find the volume in cubic meters of a right circular cylinder whose radius is 2 meters and whose height is 3 meters.

12. Solve: 3x – 2 = -2x + 5 + 4x + 8

13. Simplify: $\dfrac{8 - 2(3-1) + 5 \bullet 2}{6(-3+7)}$

14. An angle whose measure is exactly 90 degrees is called a(n) _____ angle.

15. Convert 7,000,000 square centimeters to square meters.

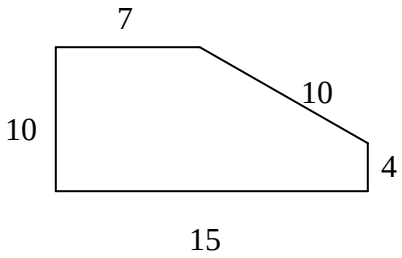
16. Simplify by adding like terms: 3x – 3y – 5x + 6y + 3 – y

17. Is the following product positive or negative?
(304)(-7)(119)(-2)(47)(-10)(515.5)

18. Multiply: $(4 \times 10^{7})(2 \times 10^{-11})$

19. Sketch a rectangular coordinate system and graph the line y = -3x + 1.

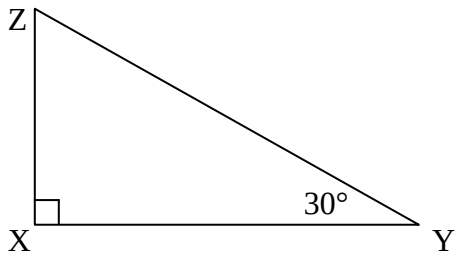
20. The base of a right solid 8 inches tall is shown. Find the total surface area.
Dimensions are in inches.



APPENDIX E

Curriculum Assessment #2

1. Find the measure of angle Z.



2. If a triangle has no sides the same length, then it is called a _____ triangle.

3. Multiply: $3x(2+x)$

4. Simplify by adding like terms: $xxx + 3x^2x + 4x^3 + 2xy - 3yx$

5. Simplify: $xy^2yx^3yx^3$

6. The ratio of big ships to small ships in the harbor was 2 to 9. If there were 242 ships in the harbor, how many were big ships?

7. Simplify: $-3^2 - (-2)^3$

8. An angle that is greater than 90° is called a(n) _____ angle.

9. Angles A and B are supplementary. If angle B measures 38°, what is the measure of angle A?

10. If 2x – 4 = 6, what is the value of 3x + 2?

APPENDIX F

Curriculum Assessment #3

1. _____ The Roman numeral M represents what number?
   A. 10 B. 50 C. 100 D. 1000

2. Any base raised to the zero power always equals what number?

3. Evaluate: $x^2y - y$ if x = -2 and y = -3

4. _____ A triangle with all sides equal in length is called a(n) _____ triangle.
   A. scalene B. isosceles C. equilateral D. obtuse

5. Multiply: x(y – x – 4)

6. Simplify by adding like terms: $3yxy + 2xyx - 6xy^2 + 3y^2x$

7. The ratio of bears to pumas in the forest was 7 to 13. If a total of 2600 bears and pumas were in the forest, how many of them were bears?

8. Simplify: $a^3m^3aa^2m^2a$

9. There are 22 marbles in a bowl: 7 are black, 5 are red, and 10 are blue. Arcelia draws a marble from the bowl. What is the probability that the marble is either black or red?

10. Kevin, the pharmaceutical salesman, receives $510 per month base pay plus 6% commission. This month he sold $130,000 in supplies. How much money did Kevin make this month?

11. Write $5\frac{1}{5}\%$ as a decimal.
    Write $5\frac{1}{5}\%$ as a fraction.

12. In a triangle, find the measure of angle A if the measure of angle B is 21° and the measure of angle C is 41°.

13. Simplify each problem: a) $\sqrt[5]{-243}$ b) 2^{-5}

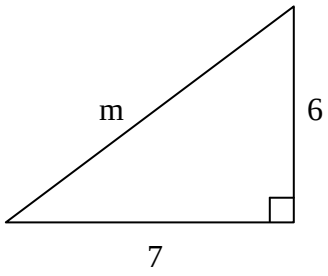
14. April is sale month at the clothing store. All items are marked down 20 percent. If the sale price for a purse is $42, what was the price before the markdown?

15. Akeem put $15,000 in the bank at 10 percent simple interest. How much money did he get when he withdrew his money after 3 years?

16. A fair coin is tossed 6 times. What is the probability of getting H, H, T, T, H, T in that order?

17. The transformation that causes a figure to look like a "mirror image" is called a _____.
A. rotation B. translation C. diagonal D. reflection

18. Find m.



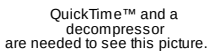
19. Solve: $x^2 = 100$

20. Write the Roman numeral for 239.

APPENDIX G

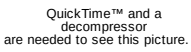
Curriculum Assessment #4

1. Find the area of the figure. Dimensions are in feet.



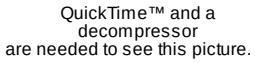
2. A polygon with 6 sides is called a(n) _____.

3. The spinner is spun 2 times. What is the probability it will stop on 2 and 4 in that order?



4. There are 21 flowers in a vase: 6 red, 7 white, and 8 blue. Jackie takes 1 flower from the vase. What is the probability that the flower is either red or white?

5. Find the measure of angle m.



6. Use the distributive property to multiply: $2x\left(x^2 + 2xy + y^2\right)$

7. Solve: $\dfrac{2\frac{4}{5}}{\frac{3}{10}} = \dfrac{x}{-\frac{1}{30}}$

8. Simplify: 2^{-3}

9. The ratio of red marbles to green marbles was 8 to 19. If there were 81,000 marbles, how many were red?

10. Simplify: $3(5 - 2 \bullet 7)$

11. Evaluate: $xy^2 + x^y$ if x = 2 and y = 3

12. If 8x + 3 = 19, what is the value of 10x – 4?

13. Simplify by adding like terms: $xyz - 2yx^2z + x^2yz + 3xxyz$

14. Graph on a number line: $x \geq -3$

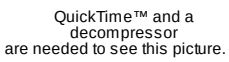
15. Solve: $4x - 33 = 3x + 4 - 2x$

16. Write 1962 with Roman numerals.

17. Angles A and B are complementary. If angle A measures 55°, what is the measure of angle B?

18. A fair coin is tossed 5 times and comes up heads every time. What is the probability that it will come up heads on the next toss?

19. Find the area of the figure. Dimensions are in inches.



20. Change 0.04% to a decimal.